Mike

SOLUTIA
Solutions for a better life.

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January 21, 2011

Mr. Bill Wentworth
Waste and Chemicals Management Division (3WC23)
United States Environmental Protection Agency
Region III
1650 Arch Street
Philadelphia, Pennsylvania 19103

Mr. Thomas Bass
West Virginia Department of Environmental Protection – OER
Office of Waste Management
601 57th Street, SE
Charleston, West Virginia 25304-2345

RE: Interim Measures Slurry Wall Installation
Slurry Wall Technical Specifications / Response to Comments
Solutia Site; 1 Monsanto Road, Nitro, West Virginia
EPA ID No. WVD039990965

Dear Bill and Tom:

Enclosed are Solutia Inc.'s (Solutia) responses to the Agencies' comments received during the December 1, 2010 meeting at Potesta & Associates, Inc.'s (POTESTA) offices to discuss Solutia's November 5, 2010 submittal, "Draft Slurry Wall Technical Specifications." As agreed in follow-up communications, Solutia has included a discussion of the deliverables that will be produced by the slurry wall installation contractor who will be selected as an outcome of the Request for Proposal (RFP) process. The deliverables that are listed will be submitted to the Agencies for review, comment and approval, prior to performance of any intrusive activities.

Please advise if the Agencies' comments on the Slurry Wall Technical Specifications document have been adequately addressed by this response and please confirm that you have no objection to Solutia proceeding as described above.

If you have any questions regarding this submittal, please call me at (314) 674-6717 or I can be reached via e-mail at mlhous1@solutia.com.

Sincerely,

Michael House

Michael L. House
Manager, Remedial Projects
Solutia Inc.

Attachments

c: Jason T. Smithson – US Army Corps of Engineers, Huntington, WV
Ron Potesta, Mike Light, Chris Grose, Mark Kiser - Potesta & Associates

SOLUTIA NITRO SITE INTERIM MEASURES

Re: Draft Slurry Wall Technical Specifications, dated November 5, 2010
Comments and Responses from December 1, 2010 Review Meeting

Attendees:

Mike House – Solutia
Jason Smithson – USACE
Ken Andromalos – GeoSolutions
Tom Bass – WVDEP
Bill Wentworth – USEPA
Chris Grose – Potesta
Ron Potesta – Potesta
Mike Light – Potesta
Mark Kiser - Potesta

USACE COMMENTS

Comment 1: *Section 7.0 talks about what will be done with the excess slurry but doesn't mention what will happen to the excavated soil. If it is to be placed on adjacent areas, the specs should designate where those areas are. If it contains contaminants and depending on those levels, there may be only a few select locations it could be taken.*

Response: Section 7.0 will be revised to state that excess soils will be placed within the limits of the slurry walls – an area that will receive a Low-Permeability (WV33CSR1 –Subtitle C) Cap.

Comment 2: *The specs should include the lab's qualifications/certification requirements.*

Response: Qualifications / certification requirements will be added to the specifications. See Section 1.3.1 Qualifications of Contractor.

Comment 3: *I only noticed that erosion control measures were shown on the drawings but they should also be discussed in the specs sections.*

Response: Erosion controls will be a requirement of the selected contractor's Installation Plan. The Agencies will have the opportunity to review and comment on the selected slurry wall contractor's Installation Plan prior to any intrusive activities in the field.

Comment 4: *The Work Plan for the Interim Geotechnical Study details IDW, PPE and decon of the drilling equipment and such. I didn't get to see the report from this study, but the fact that decon was being conducted indicates the wall is being constructed in*

a potentially contaminated area. The specs do not mention anything about this, nor any provisions for working in such media. Please include this type of information if applicable. If the area is contaminated, it will have a bearing on the construction contractor's estimate.

Response: Solutia is in agreement with this Comment. To address this issue, a Storm Water Runoff and Water Management Plan will be a requirement of the selected contractor. The contractor will receive detailed Site characterization information to be used in development of this document. The Storm Water Runoff and Water Management Plan prepared by the contractor will be submitted to the Agencies for review prior to commencement of intrusive activity.

Comment 5: *The specs should include reference to documents detailing past investigations to inform the construction contractor of the site conditions/contaminants of the soil and groundwater.*

Response: The RFP will reference the RFI and EFRI in the General Conditions to Contract section. These documents contain complete characterization information on Site conditions / contaminants of the soil and groundwater. Copies of the referenced documents will be submitted with the RFP.

Comment 6: *The specs should include requirement for SSHP.*

Response: The specs will include a requirement for a Site Specific Health and Safety Plan (HASP). The RFP will provide reference documents on the Site, including the HASP for Interim Measures Geothechnical Study. This document provides comprehensive and specific Site health and safety information sufficient for the contractor to develop his own HASP.

Comment 7: *Once the walls are constructed, will the construction contractor be held accountable for their integrity? I didn't' see any provisions for any kind of warranty or guarantee on the construction contractor's part.*

Response: The general conditions to the contract will include the warranty requirements of the contractor. It is further understood that Solutia will continue to be accountable to the Agencies for performance of the Interim Measures and attainment of the Site objectives – post-construction of the Interim Measures.

Comment 8: *Is there a groundwater concern during the excavation efforts since excavation will be below the groundwater level? Also, if the groundwater is contaminated, how will that be handled? Treatment/disposal may require some type of permit if the water will be discharged onsite, etc.*

Response: It will be necessary to add significant quantities of water to the soil bentonite slurry in addition to utilization of any groundwater that may be available from the

excavation. Therefore, management of excess groundwater will not be an issue during the slurry wall installation.

Comment 9: *General comment – the drawings outline the Solutia property boundaries but not necessarily the CWL for each wall. Some of the walls seem very close to the Kanawha River. If the construction contractor plans to do any kind of activity/work below the "ordinary high water mark," he will need to coordinate with USACE to obtain a temporary construction work permit (Nationwide Permit 33) or other, depending on the situation. Please contact LuAnne Conley at USACE (304-399-6912) for permitting issues in WV.*

Response: The RFP defines the work areas and allows the contractor to set up certain operations outside of those work area. The RFP also required the contractor to leave the site areas unrelated to the Work equal-to or better than original condition.

The slurry walls will be constructed at approximately 30 feet minimum from the top-of-bank along the river boundary. It will not be necessary for the slurry wall contractor to perform any work below the "ordinary high water mark" to construct the slurry walls. However, the HUB storm water drain way pipeline installation has been recently added to the scope of work for the project. This work will require work below the "ordinary high water mark." Therefore, as suggested, Solutia will contact LuAnne at USACE in regard to this activity and acquire the appropriate permits.

Comment 10: *Will any type of monitoring be put in place to determine if the wall was installed correctly to ensure nothing is migrating outside the limits of the wall?*

Response: See Response to Comment 11 below.

Comment 11: *General comment – the boring logs indicate the wall will be keyed into shale – sometimes clayey, sometimes not. Is it fractured and if so, is there a concern for groundwater flowing through this layer to where the wall couldn't get a seal?*

Response: In addition to numerous QA/QC procedures that will be employed during the slurry wall construction process to optimize the quality of the seal at the slurry wall / bedrock interface, Solutia will also pump groundwater from the contained areas to insure that a negative hydraulic gradient (i.e. from outside to inside the contained area to inside) is maintained.

Comment 12: *Page 6, Section 2.3 Water – They state that the water from the Kanawha River is acceptable for mixing the slurry. I think the water will be fine but it must meet the criteria described in the first sentence. This should be stated clearly.*

Response: Water from the Kanawha River is expected to be used to form the soil bentonite slurry. Kanawha River water has been tested in the laboratory and empirically

demonstrated to be an acceptable source of mix water. However, the Specifications will clearly that the Slurry Wall Specs must be met under all circumstances.

Comment 13: *Page 8, Section 4.2 Slurry Batching Plant – If a storage pond is desired then a specification for the pond should be included.*

Response: Storage ponds are not expected to be used for this project since adequate water supply is available via the Kanawha River. In the unlikely event that they would be required, specifications will be developed/approved prior to construction.

USEPA/WVDEP COMMENTS

Comment 1: *Will flowing sands be an issue and if so, how will they be addressed?*

Response: Although flowing sands are known to exist at the site, they are not expected to present a problem for the slurry wall installation since the phreatic surface is 25 to 30 feet BGS. This will provide sufficient hydraulic head from the soil-bentonite slurry mixture to more than neutralize any flowing sands that may be encountered.

Comment 2: *When will the Health and Safety Plan (HASP) be developed?*

Response: The general Site HASP will be adapted by the selected slurry wall contractor for the pathway clearing and slurry wall installation project work. The Agencies will have an opportunity to review the project specific HASP and comment / approve prior to initiation of intrusive activities.

Comment 3: *Page 6, Section 2.4 Additives - Need to clarify language as to acceptable impurity levels.*

Response: The following sentence will be added to Section 2.4: "Any additives must be approved by the Engineer prior to using." The "Engineer" is defined in the Specifications as Potesta & Associates, Inc.

Comment 4: *Page 8, Section 5.1 Exploration Pre-Trenching (Utility Clearing) – How will waste (such as Santoquin, etc.) that may be encountered during the pathway clearing process be addressed? "Borrow" and "waste" should be defined.*

Response: Non-native materials within the excavated soils encountered the clearing will be assessed by the Contractor and Solutia to determine the potential for the subject material to have a detrimental effect on the slurry wall performance. If assessed to be potentially harmful to performance of the slurry wall, the affected soils will be set aside and safely managed within the slurry wall footprint for eventual inclusion within the area that is to receive a low permeability cap. Alternatively, dependent on its characteristics, some non-native materials (waste, debris, etc.)

may be better managed by placement in the A3 Basin. This alternative will be reviewed with the Agencies on a case-by-case basis.

Comment 5: *Page 9, Section 5.3 Key – The definition of "Refusal" as related to the key depth should be more clearly defined.*

Response: Section 5.3 has been changed (shown in red) to read as follows:

"Unless otherwise directed, the bottom of the slurry trench will be keyed a minimum of 3 feet into the specified stratum (weathered bedrock) indicated on the drawings. The excavating buckets shall be equipped with Hensley Tiger Teeth or equivalent teeth designed to get maximum penetration into hard strata. If the backhoe or clamshell is unable to achieve the minimum specified penetration into the weathered rock with the assistance of ripping teeth, or drop chisels, the minimum penetration requirements will be modified and the trench excavation will be terminated at refusal of the excavating equipment. Refusal is defined as less than 6 inches of penetration in 15 minutes of continuous effort with a minimum 75 metric ton class excavator. The depth to the top of the stratum shall be measured after the desired key material is identified in the excavation spoils. The final depth and key penetration of the trench shall be measured and checked by the Contractor and approved by the Engineer immediately following excavation. At the discretion of the Engineer, the key may be reduced to 2 feet based on the degree of weathering, or the Engineer may require that the key be increased from 3 feet to 5 feet into bedrock. Any increased excavation beyond the required 3-foot key would be compensated at an agreed to additional cost.

Comment 6: *Page 9, Section 5.4 Cleaning Trench Bottom – The paragraph seems vague with respect to cuttings, etc.*

Response: The following statement will be added to Section 5.4:

> "Cuttings that are removed from the trench may be blended back into subsequent backfill or wasted and disposed within the confines of the area(s) surrounded by the slurry wall(s)."

Comment 7: *Page 10, Section 5.5 Backfill Mixing – How is "waste" defined and will it be included in the backfill mix"*

Response: "Waste" will be defined as:

> "… debris, free product, other non-native material, oversized material, soil visually impacted with tar-like material, or other material could be detrimental to the final properties of the backfill."

"Waste" will not be included in the backfill mix.

Comment 8: *Page 15, Table 1 Soil-Bentonite Slurry Trench Quality Control Testing Plan – Should the Requirement for the "YO/PV Ratio" for Bentonite Powder be "< 3" vs. " > 3"?*

Response: The original draft of Table did incorrectly state the YO/PV Ratio for Bentonite powder as " > 3." It will be changed to correctly read "< 3."

Comment 9: *A copy of the Request for Proposal will be submitted to the USEPA (Bill Wentworth) and WVDEP (Tom Bass) as requested.*

SLURRY WALL CONTRACTOR DESIGN DELIVERABLES

Prior to initiation of any on-site activity, the Contractor will be responsible for the preparation of various submittals. These submittals include, but are not necessarily limited to:

- Health and Safety Plan
- An Operations Plan
  - Construction Schedule
- Contingency Plan
- Storm Water Pollution Prevention Plan

These design submittals will be developed by the Contractor based on the current conditions at the Nitro work site, the requirements of this RFP, included project reference documents and discussions with Solutia and its consultants.

1. Health and Safety Plan (HASP)

Prior to initiation of any on-site intrusive activities, the selected Contractor will prepare a project HASP, certified by an appropriately qualified safety professional, that identifies the health and safety procedures, methods, and requirements to be implemented by the Contractor during the performance of construction activities. The Contractor's HASP shall cover all personnel who will be employed by the Contractor to perform remedial work at the work site, including direct employees as well as Subcontractors.

If the Contractor does not wish to include Subcontractors under its HASP, then each Subcontractor will be responsible for developing and implementing a HASP that meets the requirements outlined in the RFP. The Contractor will be responsible for ensuring that all of its Subcontractors have adequate HASPs prior to on-site work by the Subcontractor and are adhering to the HASPs during the work activities. If a Subcontractor agrees to be included under the Contractor's HASP, then a statement to this effect shall be submitted to Solutia. The minimum requirements/conditions that shall be included in the Contractor's (or any of its Subcontractor's) project-specific HASP are discussed below.

- Prior to commencement of construction activities, the Contractor must certify that personnel employed at the work site, including employees and Subcontractors, have completed 40-hour Occupational Safety and Health Administration (OSHA) training (and annual refresher training) in accordance with 29 CFR 1910.120 and 29 CFR 1926.65. The Contractor must also certify that any individuals who later became employed by the Contractor also receive such training prior to performing work at the work site.

- The Contractor must certify that all personnel who will be employed by the Contractor to perform work, including direct employees as well as Subcontractors, have received the initial and annual (if applicable) medical examinations and are enrolled in an on-going medical surveillance program as required by 29 CFR 1910 and 29 CFR 1926.

- The Contractor must also comply with the Department of Labor Safety and Health Regulations for construction promulgated under the Occupational Safety and Health Act of 1970 (PL 91-596) and under Section 107 of the Contract Work Hours and Safety Standards Act (PL 91-54).

- The Contractor will be responsible for the safety of his/her employees, Subcontractors, suppliers, and other parties at the site as a result of the Contractor's direction.

- The Contractor must prepare, submit, and implement a HASP in accordance with 29 CFR 1910.120 and 29 CFR 1926.65. The plan must address, but not be limited to, the following components:

  - *Identification of Key Personnel*: Identify, by name and by title, the on-site and off-site health and safety personnel responsible for the implementation of health and safety procedures. All on-site personnel involved in the measures must have OSHA 40-hour Hazardous Waste Training (29 CFR 1910.120 and 1926.65) and the corresponding 8-hour refresher course update.

  - *Training:* Each designated employee, operator, and driver must have completed applicable training and licensing. Contractor and Subcontractor employees will also be responsible for obtaining Solutia Inc.'s general site safety orientation.

  - *Drug Testing:* The Contractor's drug testing program will be submitted to Solutia for review and approval prior to commencement of construction activities. Solutia reserves the right to require additional testing for project personnel. At a minimum, the Contractor must certify to Solutia that all site personnel have had a negative drug test in accordance with Solutia policy.

  - *Medical Surveillance:* Certify that all supervisory and on-site personnel have received appropriate medical examinations and are able to conduct the tasks required for this project.

  - *Task-Specific Hazard/Risk Analysis:* Identify and provide a means of mitigating all foreseeable biological, chemical, and physical hazards associated with the work including, but not limited to, hazards associated with exposure to constituents of concern, heavy equipment operation, site conditions, weather, materials handling, work around excavated areas, and work near water.

  - *Work Zones:* Provide a site plan which depicts the designation of zones, including: (1) Exclusion Zones, (2) Decontamination Zones, and (3)

Support Zones. The level of personal protection required for each zone must be included.

- *Personal Safety Equipment and Protective Clothing:* Identify personal safety equipment and protective clothing to be available at the work site and used by project personnel. This shall include identifying expected levels of protection (EPA Protection Levels A, B, C, and D) for each task and the action levels for personal protective equipment (PPE) upgrades. A respiratory protection program that meets the requirements of 29 CFR 1910.134 and establishes specific requirements for respirator use shall be included.

- *Personal Air Monitoring:* Identify protocols and criteria associated with personal air monitoring of on-site personnel.

- *Personnel Decontamination:* Describe methods and procedures to be used for personnel decontamination.

- *Confined Space Entry:* Describe procedures for confined space entry in accordance with OSHA's Confined Space Standard.

- *Material Safety Data Sheets:* Provide Material Safety Data Sheets (MSDSs) for all materials to be brought on site, as well as constituents which are expected to be encountered in the course of implementation of the remedial activities.

- Construction Safety Procedures (OSHA 1926.1 - 1926.652, Subpart A-P) to address excavation shoring and trenching safety, as well as a daily site safety inspection checklist to evaluate these items.

- Standard Operating Procedures (SOPs) and Safety Programs as required by applicable sections of 29 CFR 1910 and 1926.

2. Slurry Wall Installation Plan

Prior to implementing intrusive work activities, the Contractor shall submit a Slurry Wall Installation Plan for review and approval by Solutia and the Agencies. The purpose of the Operations Plan is to summarize the materials, procedures, and controls that the Contractor intends to utilize during construction activities. The Operations Plan should be of sufficient detail to allow planning and coordination by Solutia and the Agencies as may be required.

This plan will address, but not be limited to, the following items:

- List/schedule of equipment to be used during construction
- Property protection procedures

- Construction Schedule
- The Contractor's proposed plan for controlling vehicular and pedestrian traffic during the performance of construction activities
- Work Zone Storm water run-on and run-off; erosion; noise; and dust control measures
- Equipment cleaning and decontamination procedures

Construction Schedule

The Contractor must submit a proposed Draft Construction Schedule to Solutia for review and approval. The Draft Construction Schedule should be neatly prepared and indicate all anticipated start and completion dates. Additional requirements are provided below:

- At a minimum, the following work items should be included:
  - Mobilization
  - Site Preparation
  - Erosion and Sediment Control
  - Utilities Clearing
  - Slurry Preparation
  - Slurry Trench Excavation and Backfill
  - Final Clay Cap Over Slurry Wall
  - Seeding and Mulching
  - Site Restoration Activities
  - Demobilization

- Show complete sequence of construction by activity, identifying work of separate stages and areas (PA, PDA, and WTA) and other logically grouped activities, including work by Subcontractors. Indicate the early and late start, early and late finish, float dates, and duration; and

- Revise and resubmit construction progress schedules on a weekly basis.

3. Contingency Plan

The Contractor must prepare, submit, and implement a Contingency Plan that includes, at a minimum, the following items:

- A spill prevention control and countermeasures plan for all materials brought to the work site (e.g., equipment, fuel).
- Emergency vehicular access/egress.
- Evacuation procedures of personnel from the work site.
- A list of all contact personnel with phone numbers, including: Solutia; the Contractor; the City of Nitro fire official(s); ambulance service; local, county, and State Police; and local hospitals, including routes to local hospitals and procedures for notifying each.

- Identification of responsible personnel who will be in a position at all times to receive incoming phone calls and to dispatch Contractor personnel and equipment in the event of an emergency situation. The telephone number(s) must be supplied to Solutia not less than seven days prior to the commencement of work.

4. Storm Water Pollution Prevention Plan

The Solutia Site storm water is regulated by a National Pollutant Discharge Elimination System (NPDES) permit - WV/NPDES Permit Number WV0116181 dated February 26, 2010 (Storm water Permit). Effluent parameters required to be monitored and reported include: flow; BOD; TSS; pH; COD; Priority Pollutants, total effluent; and 2,3,7,8-TCDD Dioxin. Storm water is directed to two discrete outlets, Outlets 001 and 002. Outlet 001 is receives storm water from the PA and PDA. Outlet 002 receives storm water from the WTA.

The Contractor shall install and maintain best management storm water practices around all disturbed areas, whether work areas, support areas, or access routes. Disturbance or exposure of any existing on-site soils has the potential to adversely affect NPDES monitoring results.

The Contractor shall erect silt fence or other suitable barriers down gradient of roadways where the Contractor's use of the roadway could cause ground disturbance. This includes ground disturbance by tracked or wheeled equipment or trucks, spilled or tracked soil, slurry, or soil-bentonite mixtures, and any other operations that could cause storm water pollution.

Storm water management and best management practices shall be required for roadways, staging areas, laydown and storage areas, work areas, and all other areas used by the Contractor.

SECTION 1000 – SOIL-BENTONITE SLURRY WALL

1.0 SCOPE OF WORK

This section of the specifications includes requirements for the Soil-Bentonite Slurry Wall and related work as indicated on the drawings and as hereinafter specified. The work consists of furnishing all plant, labor, equipment, and materials and of performing all operations as required to construct the slurry trench cutoff wall.

The project consists of four slurry walls located in three work areas separated by a short distance. They are referred to in this document and other places in the Plans and Specifications as:

- PA Process Area
- PDA Past Disposal Area
- WTA-East Waste Treatment Area – East
- WTA-West Waste Treatment Area – West

1.1 Reference Standards

Following is a list of standards, which will be referenced in this specification. Such referenced standards shall be considered part of these specifications as if fully repeated herein.

REFERENCE	*TITLE OR DESCRIPTION*
API Spec 13A	API Specification for Oil-Well Drilling-Fluid Materials
API RP 13B-1	API Recommended Practice Standard Procedure for Field Testing Water-Based Drilling Fluids
ASTM C 138	Test Method for Unit Weight of Concrete
ASTM C 143	Test Method for Slump of Concrete
ASTM D 422	Particle-Size Analysis of Soils
ASTM D 1140	Materials Finer than No. 200 Sieve
ASTM D 4318	Liquid Limit, Plastic Limit and Plasticity Index of Soils
ASTM D 4380	Density of Bentonite Slurries
ASTM D 4381	Sand Content by Volume of Bentonite Slurries
ASTM D 5084	Hydraulic Conductivity Using a Flexible Wall Permeameter

1.2 Abbreviations and Definitions

A. API - American Petroleum Institute.

B. ASTM - American Society for Testing and Materials.

C. Owner - The Owner as referred to herein is Solutia Inc.

D. Owner's Representative - Potesta & Associates, In. (POTESTA) – or POTESTA's designee – has been designated by the Owner to be the "Engineer" and act on its behalf in the execution of these specifications. The POTESTA primary contact is Mike Light (304-561-4601) and in his absence, Mark Kiser (304-342-1400). In addition, a POTESTA representative will be on-site when work is being performed.

E. Slurry Trench - A narrow, vertical-walled trench of specified width excavated by the slurry trench method and backfilled with specified materials to form a cutoff wall of low permeability. The terms "Slurry Trench" and "Slurry Wall" are used interchangeably in these specifications.

F. Slurry Trench Method - A method of excavating a narrow, vertical trench using a slurry mixture to support the trench walls and prevent movement of groundwater into or through the excavated trench.

G. Water-Bentonite Slurry - A stable colloidal suspension of powdered bentonite in water. The terms "slurry" and "bentonite slurry" are used interchangeably in these specifications.

H. Soil-Bentonite (SB) Backfill - A homogeneous mixture of specified soil material, bentonite and water. The terms "soil-bentonite backfill" and "backfill" are used interchangeably in these specifications.

I. Slurry Trench Specialist - An individual who has had proven and successful experience in slurry trench construction and is knowledgeable of: (1) the proper methods employed to mix slurry and backfill, (2) the use, testing and control of bentonite as a slurry, (3) construction equipment, (4) excavation and backfill operations, and (5) testing for slurry trench quality control.

J. Working Platform - The working platform is the surface of compacted fill and/or excavated surface from which the slurry wall is constructed.

1.3 Submittals

The following information shall be submitted at least 4 weeks prior to construction.

1.3.1 Qualifications of Contractor

The Contractor, his subcontractor or his consulting advisor, shall submit evidence that he is experienced and competent to construct a soil-bentonite slurry trench. The slurry trench company shall have at least five years of prior experience in constructing slurry walls. This evidence will insure that the Contractor will have sufficient competent experienced personnel to carry out the operations specified.

In particular, a slurry trench specialist shall supervise the construction, slurry preparation, and quality control. The slurry trench specialist shall have at least five years of experience and five projects in successful construction of slurry walls with depths in excess of 50 feet and having lengths of at least 1000 linear feet in each case.

The company name, key contact, and qualifications of the Contractor's off-site laboratory shall be submitted. The laboratory will have previous experience with slurry wall materials, experienced laboratory technicians, and modern triaxial permeability testing equipment. The off-site laboratory shall also be qualified to conduct material tests for the U.S. Army Corps of Engineers (USACE) and be listed on the USACE Materials Testing Center homepage at http://www.wes.army.mil/SL/MTC/mtc.htm.

1.3.2 Slurry Wall Operations Plan

The Contractor shall submit a detailed operations plan describing his proposed construction equipment, procedures, and schedules. This shall include, but not be limited to, the Contractor's plan for:

A. Coordinating the construction, maintenance and removal of working platforms, mixing pads, and haul roads with the Owner, general contractor or other contractors on-site.

B. Equipment set-up and site use layout including storage areas, haul roads and work platform dimensions.

C. Equipment specifications including: maximum depth capability of excavator; number and type of backfill mixing equipment; and specifications of slurry mixing equipment.

D. Procedure for water-bentonite slurry mixing, transportation and re-circulation.

E. Procedure for trench excavation and backfilling.

F. Material properties, sources, and (manufacturer's) certificates of quality.

G. Control of drainage, spills, wastes, etc.

H. Clean-up, spoils disposal, slurry disposal.

I. Procedures for general earthwork as outlined in Section 1100, Earthwork.

1.3.3 Quality Control Plan

The Contractor shall submit a quality control plan with details of the personnel, responsibilities, inspections, and organization for insuring the quality of construction required by these specifications. The plan shall provide a table listing testing methods, frequencies, and minimum acceptable values. The plan shall explain the methods and locations for obtaining samples for testing and reporting schedules. Copies of quality control forms shall be submitted for review and approval.

1.3.4 Bar Chart Schedule and Sequence of Operations

The Contractor shall submit a detailed schedule and sequence of operations for installation of the four slurry walls in a bar chart format. The submittal shall include a description of the schedule including typical working hours and days; sequence of operations; and maintenance schedule.

1.3.5 Design Mix

A pre-construction, laboratory design mix program has been completed to determine appropriate materials and material proportions for the required slurry wall performance. A copy of the report from the program conducted by Geo-Solutions Inc. will be furnished to each contractor bidding the work. (Attachment J of the RFP)

The Contractor may use the Design Mix as described in the referenced design mix report or may propose his own Design Mix. In cases where the Contractor will propose his own Design Mix, the following specific information shall be submitted prior to the start of slurry wall construction:

A. Sampling Plan. A description of the methods and locations of all samples used in the design mix testing. Mixing water, groundwater, native soils, bentonite clay, and borrow soils (if needed) should be obtained and tested.

B. Compatibility Testing Report. Report to include the results of chemical desiccation test, filter cake permeability tests, and sedimentation/flocculation tests. The successful design mix shall be subjected to long-term permeability tests with the groundwater.

C. Laboratory soil-bentonite design mix and trial mix reports, including proportions, density, bentonite content, moisture content, gradations, and hydraulic conductivity on at least four (4) samples of the proposed design mix.

D. Source and properties of all materials proposed for use in the slurry and soil-bentonite (water, bentonite, native soils, borrow soils, and any admixtures).

Whether or not the Contractor uses the information supplied by the Owner for his design mix or if the Contractor proposes his own design mix, the Contractor will be responsible for meeting the performance standards for the backfill as specified in this section.

1.4 Reports

The following information shall be submitted to the Engineer on a regular schedule during the progress of the work. Daily reports shall be submitted by noon of the day following the date of the report. Laboratory test results shall be submitted within 2 days of receipt of the report from the laboratory. Final reports shall be submitted within four weeks of the completion of work.

1.4.1 Soundings and As-Built Profile

A record of soundings taken during construction including the depth of the trench, key, and backfill slope obtained each morning and evening by the slurry specialist. Soundings shall be taken at 10-foot intervals of the backfill and trench bottom. The soundings shall be used to generate an as-built profile of the trench, as constructed.

1.4.2 Fresh Bentonite Slurry Mix

A record of plant-mixed bentonite slurry quantities, proportions, properties, and admixtures made during construction. Adjustments to the slurry mixture shall be noted.

1.4.3 Trench Bentonite Slurry Mix

A record of in-trench bentonite slurry properties made during construction. Procedures and admixtures used to modify slurry properties shall be noted.

1.4.4 SB Backfill Mix

A record of SB backfill material quantities, properties, and mix adjustments made during construction. Location of samples for laboratory testing shall be noted.

1.4.5 Quality Control Data

A record of quality control samples, tests and test results.

2.0 MATERIALS

2.1 Slurry

Slurry shall consist of a stable colloidal suspension of bentonite in water and shall be controlled in accordance with the most current API Recommended Practice 13B-1, and the following requirements:

A. At the time of introduction of the slurry into the trench, the slurry shall be a mixture of not less than 5 percent bentonite in water. Additional bentonite or admixtures may be required depending on the hardness and temperature of the water and the quality of the bentonite. The slurry shall have a minimum apparent viscosity of 38 seconds reading through a Marsh Funnel Viscometer, a pH between 6 and 9 units, a minimum density of 64 pcf (1.03 gm/cc), and a filtrate loss of 20 cubic centimeters in 30 minutes at 100 psi.

B. The slurry mixture in the trench shall have a unit weight not less than 64 pcf (1.03 gm/cc), not greater than 85 pcf (1.36/gm/cc) or 15 pcf less than the backfill unit weight (whichever is less), or as approved by the Engineer.

2.2 Bentonite

Bentonite used in preparing slurry shall be pulverized (powder or granular) premium grade sodium cation montmorillonite and shall meet the most current API Standard 13A, Section 9. In particular, the nominal yield of the bentonite shall be 90 barrels per ton.

2.3 Water

Fresh water, free of excessive amounts of deleterious substances that adversely affect the properties of the slurry shall be used to manufacture bentonite slurry. It is the responsibility of the Contractor that the slurry resulting from the water shall always meet the standards of this specification. It will be acceptable to use water from the adjacent Kanawha River as mixing water. The Contractor shall be responsible for regulatory requirements, approvals, and reporting in the event he decides to use water from the Kanawha River.

2.4 Additives

Admixtures of the type used in the control of oil-field drilling mud such as softening agents, dispersants, retarder or plugging or bridging agents may be added to the water or the slurry to permit efficient use of bentonite and proper workability of the slurry. Any additives must be approved by the Engineer prior to using.

2.5 Backfill

The material for trench backfilling shall be composed of fresh slurry, trench slurry and selected soils obtained from a designated off-site borrow area and/or trench spoils. Trench slurry may be disallowed if additives are not acceptable to the Engineer. The soil shall be friable and free from roots, organic matter, refuse, or other deleterious materials. The backfill shall be thoroughly mixed and reasonably well graded between the following gradation limits:

Screen Size (U.S. Standard)	Percent Passing By Dry Weight
3"	100%
No. 200	>25% to < 80%

The permeability of the backfill shall be less than $1x10^{-7}$ cm/sec. The slump of the backfill shall be 4 to 7 inches, and the density of the backfill shall be at least 15 pounds per cubic foot greater than the density of the slurry.

The backfill design recommended by Geo-Solutions contains a minimum of 2 percent (by dry weight) of dry bentonite added to the backfill blend. The Contractor's mix design must include at least 2 percent by dry weight of dry bentonite addition to the backfill.

3.0 SLURRY TRENCH CUTOFF WALL

A slurry trench cutoff wall shall be constructed to the lines, grades, and cross sections indicated on the drawings. The trench shall have essentially vertical walls, a minimum width of 36 inches, and shall extend through the overburden and key as described in Section 5.2 into the designated stratum. A generalized description of the soil profile through which the slurry trench cutoff is to be constructed is provided on the boring logs attached to this specification (see Appendix A).

3.1 Tolerances

The following tolerances shall apply to the slurry trench dimensions and construction.

A. The slurry trench shall be essentially vertical. The working platform and/or excavating equipment may be leveled to be plumb within 3 percent of vertical.

B. The depth of the slurry trench shall be measured or surveyed to within 6 inches of the desired elevation, provided that the key shall be constructed in the desired formation.

C. The excavating tool shall be at least as wide as the design width of the slurry trench.

D. The slurry trench shall follow the designed alignment within 2 feet of the centerline. The slurry trench may vary from the designed alignment, e.g., at corners or turns, if approved by the Engineer.

E. Construction will not be permitted when the air temperature is below 20°F or when severe weather conditions may compromise the quality of the work.

F. Overlaps and changes in direction of the slurry trench shall require an over excavation at least 7 feet beyond the centerline of the trench. In cases where the trench must be

re-excavated (for example, due to an extended shutdown, cave-in, rework, etc.) the overlap into acceptable backfill shall be at least 10 feet.

4.0 EQUIPMENT

4.1 Trench Excavation

Excavation of the slurry trench cutoff wall shall be accomplished by use of any suitable earth-moving equipment, or combination thereof, such as a backhoe, clamshell, chisels, and ripper teeth so the trench can be carried to its final depth of cut continuously along the trench alignment. The excavator shall have the capability to excavate at least 10 feet deeper than the maximum depth shown on the Drawings. Special chopping, chiseling or other suitable equipment may be used as necessary to satisfactorily accomplish the required excavation. The width of the excavating tool shall be equal to or greater than the specified minimum width of the slurry trench. Additional equipment such as airlift pumps and slurry desanders shall be used, if required, to clean the trench bottom slurry in accordance with the requirements of the specification. The trench excavation equipment shall be capable of excavating the required key into the designated stratum.

4.2 Slurry Batching Plant

The slurry batching plant shall include the necessary equipment including a high shear mixer capable of producing a colloidal suspension of bentonite in water, pumps, valves, hoses, supply lines, and all other equipment as required to adequately supply slurry to the trench. Storage ponds [or tanks] shall be provided [as needed] to store initially mixed slurry to allow hydration, and to retain a reserve in case substantial slurry loss through underlying pervious zones occurs. Slurry held in storage shall be agitated or recirculated to maintain a homogeneous mix. All slurry for use in the trench shall be prepared using a suitable mixer. No slurry is to be made in the trench. Mixing of water and bentonite shall continue until bentonite particles are fully hydrated and the resulting slurry is homogeneous.

4.3 Backfill Mixing and Placing

Equipment for mixing and placing backfill may consist of any suitable earthmoving or grading equipment, such as bulldozers, or blade graders or backhoes, or blenders such as a pug mill, that are capable of thoroughly mixing the backfill materials into a homogeneous blend having the required gradation and properties and placing the material in the trench as specified. Soil clods shall be broken to 4-inch maximum size by the backfill preparation equipment and methods employed. Deleterious materials and debris, oversize particles, shall be removed from the backfill before placement.

5.0 EXECUTION OF THE WORK

5.1 Exploratory Pre-Trenching (Utility Clearing)

Prior to excavating under slurry, the Contractor shall conduct pre-trenching operations along all wall alignments to locate, cut and plug utilities that may interfere with the work (except any that are specifically identified to remain). The pre-trenching operations will also be designed by the contractor to locate and remove any other obstructions that might interfere with the slurry wall excavation. The minimum depth of pre-trenching shall be 6 feet or to the depth of any potential utilities or obstructions shown on the Drawings (whichever is deeper). Pre-trenches shall be immediately backfilled with select soils compatible with the Contractor's slurry wall backfill design.

5.2 Slurry Trenching

Excavation shall proceed continuously from the starting point to the finishing point. Slurry shall be introduced into the trench at the time trenching begins and shall be maintained in the trench during excavation and until backfilled. The Contractor shall maintain the stability of the excavated trench at all times for its full depth. The level of the bentonite slurry shall always be maintained at least 3 feet above groundwater level and shall not be permitted to drop more than 2 feet below the surface of the working platform. The Contractor shall have personnel, equipment, and prepared slurry ready to raise the slurry level at any time. To this end, the Contractor shall have personnel check the trench levels and on call to raise the slurry level weekends and/or holidays included.

5.3 Key

Unless otherwise directed, the bottom of the slurry trench will be keyed a minimum of 3 feet into the specified stratum (weathered bedrock) indicated on the drawings. The excavating buckets shall be equipped with Hensley Tiger Teeth or equivalent teeth designed to get maximum penetration into hard strata. If the backhoe or clamshell is unable to achieve the minimum specified penetration into the weathered rock with the assistance of ripping teeth, or drop chisels, the minimum penetration requirements will be modified and the trench excavation will be terminated at refusal of the excavating equipment. Refusal is defined as less than 6 inches of penetration in 15 minutes of continuous effort with a minimum 75 metric ton class excavator. The depth to the top of the stratum shall be measured after these soils are identified in the excavation spoils. The final depth and key penetration of the trench shall be measured and checked by the Contractor and approved by the Engineer immediately following excavation. At the discretion of the Engineer, the key may be reduced to 2 feet based on the degree of weathering, or the Engineer may require that the key be increased from 3 feet up to 5 feet into bedrock. Any increased excavation beyond the required 3-foot key would be compensated at an agreed-to additional cost.

5.4 Cleaning Trench Bottom

Upon completion of excavation, loose material or cuttings shall be removed from the bottom of the trench with the excavation tools or other suitable means such as air lift pumps. If the unit weight of the slurry in the trench exceeds the specified limits, or becomes unworkable, the heavy slurry shall be removed from the trench by airlift pump, clamshell, or other methods approved by the Engineer or the excess solids shall be removed from the slurry by settling ponds, screening, or desanding. The trench bottom shall be cleaned of debris and excess sand sediment prior to backfilling. The trench shall be sounded immediately before placing backfill, and soundings shall be compared to the trench excavation soundings to verify the bottom. At a minimum, soundings shall be taken each morning and each evening and compared to monitor for cave-ins or excessive sand sedimentation.

Cuttings that are removed from the trench may be blended back into subsequent backfill or wasted and disposed within the confines of the area(s) surrounded by the slurry wall(s).

5.5 Backfill Mixing

The backfill shall be mixed beside the trench or in a designated, approved remote location on site. If the backfill is mixed beside the trench, the contractor shall control and provide sufficient equipment and work platform space to support slurry spills, trench stability, and mixing equipment operation. Trench-side mixing may only be carried out on the interior side of the slurry wall alignments (i.e., within the area contained by the slurry wall). Unmixed materials shall not be placed or be allowed to fall into the trench. Backfill mixing areas shall be contained with berms to prevent unmixed backfill from flowing back into the trench or out of the designated mixing areas. If the backfill is mixed in a remote location, the contractor shall build and maintain adequate haul roads and the mixing pit or pad. The mixing pit or pad shall be lined with compatible soils or cement to prevent contamination from unsuitable materials. In either case, the contractor shall be responsible for the quality of the backfill.

Off-site borrow materials, if required, and dry bentonite shall be mixed and blended in mechanical blenders or by windrowing, disk harrowing, bulldozing, blading or by other approved methods. Mixing and blending shall be performed in such a manner as to produce the required gradation of backfill. The backfill material shall be thoroughly mixed into a homogeneous mass, free of large soil clods, lumps or pockets of fines, sand, gravel, waste materials, or debris. Occasional particles of up to 4 inches in their largest dimensions will be permitted. Just prior to placing, the backfill material shall have a slump of 4 to 7 inches. To this end, the materials shall be sluiced with slurry from the trench or fresh slurry during blending operations. Sluicing with water will not be permitted. Backfill shall be sampled and tested for permeability, density, slump, and gradation after preparation.

Any waste that is encountered in the excavation of the trench will not be included in the backfill mix. "Waste" consists of debris, free product and other non-native material, oversized material, soil visually impacted with tar-like material, or any other material that may be detrimental to the final properties of the backfill.

5.6 Backfill Placement

The backfill shall be placed continuously from the beginning of the trench, in the direction of the excavation, to the end of the trench. The toe of the slope of the trench excavation shall precede the toe of the backfill slope so that the toe of the backfill shall not be closer than 20 feet to the toe of the excavation slope, or as required to permit proper cleaning of the trench bottom as approved by the Engineer. Excavation shall not exceed 100 feet from the toe of the backfill. Excavation must permit inspection and measurement immediately after completion and prior to backfilling. Placing operations shall proceed in such fashion that the surface of the backfill below the slurry shall follow a reasonably smooth grade and shall not have hollows, which may trap pockets of slurry during subsequent backfilling. Free dropping of backfill material through the slurry is not acceptable. Initial backfill shall be placed by lowering it to the bottom with clamshell bucket or backhoe until the surface of the backfill rises above the surface of the slurry or by lead-in slope. Additional backfill may then be placed in such manner that the backfill enters the trench by sliding down the forward face of the previously placed backfill. To accomplish this, sufficient backfill shall be piled behind the crest of the existing backfill slope to cause a mudwave action at the face of the backfill. The backfill shall not be dropped or deposited in any manner that will cause segregation.

An acceptable substitute for the initial placing of backfill by the use of a clamshell bucket may be a lead-in trench. The lead-in trench shall begin at a point outside of the limits of work and provide sufficient distance for the backfill face to form, by placing the backfill into the trench, before the toe of the backfill reaches the point where the cut-off is required. The lead-in trench shall be 1 vertical to 1 horizontal (1V:1H) or flatter.

6.0 TREATMENT FOR TOP OF BACKFILL

The surface of the backfill shall not be allowed to desiccate prior to placing the final cap. A temporary covering may be used to protect the backfill prior to placing the final cap. Temporary crossing of extra thick compacted soil or trench plates shall be used for heavy equipment crossings. The temporary covering shall consist of at least 1 foot of uncompacted backfill placed within one day after the SB backfill is placed. After a minimum of one week, the temporary cover may be removed. Any depressions or settlement shall be repaired by placing additional backfill or the permanent cap.

Upon completion of backfill placement and before desiccation of the backfill surface can occur, the cutoff trench shall be covered with cohesive soils in accordance with the clay cap details shown on the Drawings.

7.0 CLEAN-UP

After completion of the backfill and capping, all remaining excavated material and slurry shall be removed and the surface shall be cleaned and leveled as directed by the Engineer. Excess slurry shall be disposed by drying, mixing with dry materials or spreading in thin layers on adjacent areas designated by the Engineer, within the limits of the slurry walls – an area that is to receive the temporary rain cover (see Section 1600). No slurry shall be left in ponds, and all ponds shall be pumped dry and backfilled in a controlled manner.

8.0 QUALITY CONTROL

The Contractor shall maintain his own quality control for the cutoff wall construction under the direction of a qualified geotechnical engineer. Testing requirements are specified herein.

8.1 Trench Continuity and Key

The Contractor shall be responsible for demonstrating to the satisfaction of the Engineer that the trench is continuous and keyed the minimum specified depth into the designated stratum. The Engineer will be available onsite to verify these measurements. Trench continuity shall be assured by the action of movement of the trench excavation equipment such that the digging tools can be passed vertically from top to bottom of the trench as well as moved horizontally along the axis of the trench without encountering unexcavated material. Penetration of the bottom of the trench into the aquaclude shall be demonstrated at 10-foot centers by observation of the excavation spoils from the trench and by direct measurement of the top of the designated stratum and the final excavated trench depth to the satisfaction of the Engineer.

8.2 Materials

A. Bentonite: Certificate of Compliance with the specification shall be obtained from the manufacturer for each shipment of bentonite delivered to the site.

B. Water: Water for slurry mixing shall be tested once at the start of the project or whenever sources are changed.

C. Prepared Backfill: Soil-bentonite backfill shall be tested prior to placement in the trench by conducting tests to determine slump and gradation. Laboratory testing of the backfill for gradation and permeability shall be conducted once for every 1000 cubic yards of backfill mixed. Permeability testing shall be performed to verify the prepared material meets specification. Permeability determinations may follow placement.

D. Fresh Slurry: A complete series of tests shall be conducted from the mixer or tank containing fresh slurry ready for introduction in the trench at least twice per shift or each time a batch is prepared.

E. Trench Slurry: Slurry in the trench shall be tested at least twice per shift. Samples shall be obtained from the mid-depth of the trench near the toe of backfill slope.

8.3 Soundings

Soundings shall be taken every 10 feet along the trench centerline using a weighted tape, cable or other device. Soundings shall be recorded to the nearest 0.5 foot. Soundings shall record the following:

A. Top of Key Stratum: The top elevation of the key stratum shall be determined based on an examination of cuttings taken during excavation.

B. Bottom of Excavation: The elevation of the trench shall be determined subject to approval by the Engineer.

C. Bottom of Excavation Prior to Backfilling: Soundings shall be used to monitor for sidewall collapse and accumulation of sediments.

D. Profile of Backfill Slope: The SB backfill slope and trench bottom shall be sounded at the beginning and end of each shift and converted to an as-built drawing. This drawing shall be reviewed daily as an indication of trench collapse, excessive settlement or sloughing.

8.4 Quality Control Testing Equipment

A. The field laboratory shall be equipped with the following equipment, at a minimum:

1. Marsh funnel and cup – 2 sets
2. Mud balance – 2 sets
3. Sounding cable – 2 sets
4. pH tape – 1 set
5. Standard Filter Press w/ graduate cylinder – 1 set
6. Slump cone and rod – 1 set
7. Sand content kit – 1 set
8. Standard #200 sieve with hot plate (or microwave oven) and balance – 1 set

B. A qualified off-site laboratory shall be engaged to perform the tests listed below. Samples shall be delivered to the laboratory on an expedited schedule and test results shall be reported the same week as the samples are received.

1. Permeability of SB backfill by ASTM D5084
2. Grainsize of SB backfill by ASTM D422

8.5 Permeability Measurements

Flexible wall permeability tests shall be conducted on samples of the backfill to determine compliance with these specifications. Samples of the SB backfill shall be obtained [from the mixing area] and sent to the off site laboratory for testing. The test parameters shall be as follows:

A. Average Effective Confining Stress = 10 psi.

B. Hydraulic Gradient = <25.

C. Permeate = tap water.

8.6 Documentation

Results of all tests performed shall be recorded on forms acceptable to the Engineer and signed by the Slurry Trench Specialist. These forms will be available to the Engineer at all times for his inspection. Copies of all quality control documents will be submitted daily to the Engineer for his verification.

As-Built profile drawing of the trench bottom and backfill slope shall be continuously maintained by the Contractor. The profile shall indicate the extent of excavation and backfill at the end of each working day. The daily profile shall be drawn in an electronic (EXCEL) format or by hand, as directed by the Engineer.

9.0 MEASUREMENT AND PAYMENT

Payment for the slurry trench shall be made at the contract price per square foot of slurry wall. Such price shall include all costs for the construction and completion of the slurry wall. No separate payment will be made for materials, equipment, slurry, records or quality control. Final acceptance of the slurry wall will be based on meeting all the requirements for the slurry wall dimensions, bentonite slurry, and permeability of the SB backfill.

Measurement for the slurry wall shall be based on the area in square feet of the completed slurry wall measured in a vertical plane through the centerline of the slurry trench from the top of work platform to the bottom of the excavated trench. Measurements shall be based on surveys and soundings taken at the site as directed and approved.

Table 1: Soil - Bentonite Slurry Trench Quality Control Testing Plan

Property	Requirement	Min. Test Frequency	Test Method	Comment
Bentonite Powder				
a. YP/PV Ratio	< 3	1 per truck or RR car	API Spec 13A	Premium Grade.
b. Viscometer at 600 rpm	> 30	1 per truck or RR car	API Spec 13A	Certification by Manufacturer
c. Filtrate Loss	< 15 cc	1 per truck or RR car	API Spec 13A	
d. Moisture Content	< 10%	1 per truck or RR car	API Spec 13A	
e. Residue larger than 75 micrometers	< 4%	1 per truck or RR car	API Spec 13A	
f. Certification		1 per truck or RR car	API Spec 13A	Section 9
Water for Slurry Mixing				
a. pH	6 to 9	1 per source	API RP 13B-1	May be modified for
b. Hardness	< 250 ppm	1 per source	Hach Test	potable source or if treated
c. Total Dissolved Solids	< 500 ppm	1 per source	Hach Test	w/additives
Initial Bentonite Slurry				
a. Viscosity	> 38 seconds	2 per shift	API RP 13B-1	
b. Density	> 64 pcf	2 per shift	ASTM D-4380	
c. Filtrate Loss	< 20 cc	2 per shift	API RP 13B-1	
d. Bentonite content	> 5%	Per project	Weight-Volume	Demonstrate
In-Trench Bentonite Slurry				
a. Unit Weight	64 to 85 pcf	2 per shift	ASTM D-4380	Also > 15 pcf less than SB
b. Viscosity	> 40 seconds	2 per shift	API RP 13B-1	
SB Backfill Material				
a. Slump Cone	4 to 7 inches	1 per shift	ASTM C-143	
b. Gradation	Per design mix	1 per 1500 cy	ASTM D-1140	Laboratory or Field Test
c. Density	15 pcf > In-trench slurry	1 per shift	ASTM C-138 or D04380 mod	
d. Permeability*	$< 1 \times 10^{-7}$ cm/sec	1 per 1500 cy	ASTM D-5084	Laboratory test

* *See Section 8.5.*